

**ABSTRACT**

An optically made, high-efficiency in-line holographic mask (ILHM) for in-line holographic patterning of a workpiece, and apparatus and methods for performing same. The ILHM of the present invention combines the imaging function of a lens with the transmission properties of a standard amplitude mask, obviating the need for expensive projection optics.

The ILHM of the present invention is formed using either a type I (non-opaque) or type II (opaque) specialized object mask having one or more substantially transparent elements which can be phase-altering, scattering, refracting and/or diffracting.

One aspect of the invention is a method of creating a pattern on a workpiece including the steps of providing an illumination beam and disposing an ILHM therein, disposing a workpiece adjacent the ILHM, and illuminating the ILHM to impart a pattern to the workpiece. An additional aspect of the invention includes a method of patterning a workpiece with an ILHM wherein the ILHM is used in combination with a lens. The ILHM is disposed such that a holographic real image is formed at or near the lens object plane, and the workpiece is disposed at or near the lens image plane. Apparatus for patterning a workpiece using an ILHM are also disclosed.

The present invention has application for wavelengths ranging from the IR to x-ray, and is well-suited for use in industrial in-line exposure apparatus for patterning a wide variety of workpieces for many different applications.

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